The University of Texas at Houston

M. D. Anderson Hospital and Tumor Institute



Department of Biomathematics

# FINAL REPORT: NAS 9 - 13042

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by

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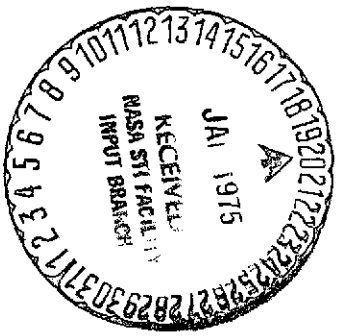


for the

National Aeronautics and Space Administration

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## 1.0 BACKGROUND AND STATEMENT OF WORK

The purpose of contract NAS9-13042 was that the contractor, M. D. Anderson, evaluate all methods used by the NASA endocrine laboratory in completion of laboratory examinations, make change recommendations, and document all procedural and logistic plans. Specifically, at least the following were to be performed:

1. Design and document formats for sample labels.

2. Design a systematic (manual or automated) sample inventory and locator system.

3. Review sample handling equipment, methods and procedures, and recommend changes as required.

4. Document the sample flow in terms of time required and personnel, and logistic equipment necessary.

5. Design a reliability study for each of the variables used in the M070 experiments, provide test-retest samples from normal subjects without intervening treatment, and complete the analysis showing expected reliability.

6. Evaluate proposed univariate statistical methods for handling test results and make recommendations for any changes. Review proposed production methods for completing these analyses. Complete independent analysis, as required, to verify statistical methods.

7. Provide problem definition and exploratory support in defining multivariate statistical methods for experimental results. Correlational analysis, cluster analysis, and multi-

variate analysis of variance and/or covariance shall be evaluated for applicability. Provide, at least, one analysis using recommended methods.

8. Evaluate endocrine series experiments in relation to other medical experiments and recommend statistical methods for evaluating these parameters. Complete, at least, one analysis of recommended methods.

9. Document all of the above into a comprehensive and step-by-step guide for laboratory and analysis personnel.

## 2.0 SUMMARY OF WORK PERFORMED

### 2.1 Laboratory Procedures

A An evaluation of laboratory procedures (Tasks 1 through 5 in Section 1) was provided during the first year of the contract. A draft version of the laboratory procedures document was provided to the head of the NASA/JSC Endocrine Laboratory, Dr. Carolyn Leach.

### 2.2 The Retrieval System

It became apparent during the first year that an information storage and retrieval system would have to be developed to facilitate the univariate and multivariate statistical analyses. To this end, the original version of the storage and retrieval system was written on M. D. Anderson's XDS Sigma 5 computer during the first year. The system built and updated a data file from sixteen different types of input cards, produced plots of the data, and performed basic univariate statistical analyses. This system was documented in December, 1973 [1].

During September, 1973 the XDS Sigma 5 computer was replaced with a larger scale CDC Cyber 73 time-sharing computer. Because of the non-availability of a suitable Sigma 5 and the additional capabilities of the Cyber 73, the system was converted to the Cyber during Fall, 1973. Because of delays and programmer difficulties, a systems analyst was placed on the conversion problem at no additional personnel cost to NASA. The contract has been staffed by the systems analyst, principal investigator, and half-time secretary since January, 1974. The conversion to

the Cyber 73 permits simplified modifications of the basic retrieval system to perform specific statistical analyses and increased file handling capabilities. The CDC System was documented in November, 1974 [2].

## 2.3 The Univariate Statistical Analyses

To complete Task 6 on a single flight, Skylab III was chosen for completeness and length prior to the end of the contract period. Several analyses were performed on the fifteen (15) blood parameters, twenty-five (25) urine parameters and nine (9) dietary parameters individually. These included tests performed on each astronaut individually. These are one-way analyses of variance, t-contrasts, Kruskal-Wallis type non-parametric analyses, and simple means and variances with 95% and 99% outlier indications. Two-way unbalanced analysis of variance with Scheffe contrasts and one-way analysis of covariance with Julian Date as the covariate were performed treating the astronauts as random effects. Periodic effects were analysed individually on each astronaut using both simple autoregressive and Fourier techniques on the inflight data formed after subtracting the resultant trends estimated by the one-way analysis of covariance [3, Section 2, 3].

## 2.4 The Multivariate Statistical Analyses

To complete Task 7, separate sequential files containing urine and diet data were prepared for each astronaut. These files were then used separately to examine relationships between parameters. All available urine parameters were compared indivi-

dually in a stepwise regression program using the dietary parameters and Julian Date as independent parameters. The incompleteness of the ketosteroids on the file available to M. D. Anderson hampered further regressions to ascertain more fundamental relational models in Skylab III. It should be emphasized here that these models are relatively easy to construct.

Principal Component Analysis was performed on several selected subsets of the sequential urine and diet files discussed above. All these subsets included the Julian Date and either all diet, all ketosteroids, all urine except ketosteroids, or urine electrolytes. Astronauts were then compared by checking each factor of one astronaut against a sub-basis of factors from another astronaut. Ketosteroids were also incomplete for these analyses.

The multivariate methods are not performed as completely as they could have been. The problem was that the interaction between the principal investigator and the NASA personnel involved was not sufficient enough to completely perform the multivariate methods. It is suggested that this phase of the research could be continued on-site at NASA/JSC. This phase of the project needs an experienced clinician, such as Dr. Leach, to supply good models of relationships between the parameters. With this assistance on an interactive day by day basis, the regression analysis could supply effective input/output models of electrolyte/protein flow. The regression analysis could also supply cause/effect models relating ADH and other hormones to electrolyte control. Indeed, the models would yield incremental change information. The principal components analysis gives major

directions of the variability of the parameters being analysed. With the interactive use of an experienced clinician, major parameters causing the observed variation can be isolated and identified without unnecessary analysis. The relative percentages of each variable are also given and can then be used in hypothesized models as well.

## 3.0 AVAILABLE DATA AND PROGRAMS

The programs documented in [2] are available on 9 track, 800 BPI tape in 80 character records. The tape consists of five (5) files plus one (1) empty file at the end. The files are:

| File | Description |
|---|---|
| 1 | Program BUILD - Set for updating files. |
| 2 | Program BUILD - Set to create files. |
| 3 | Program RETD - Without addition or modification. |
| 4 | Program RETD - Modified for analysis of variance. |
| 5 | Program RETD - Modified for analysis of covariance. |

The data and programs are also available as a complete permanent file dump of the endocrine account. The dump was made to 9 track, 800 BPI tape by the CDC Kronos 2.1 PF Utility Program. It contains the eleven (11) files.

| File | Description |
|---|---|
| 1. BUILDPL | Modify program Library of CREATE/UPDATE. |
| 2. RTREVE | Modify program Library of Retrieval Program. |
| 3. ANFILE | Source program of analysis of variance subroutines in Modify Source Input Form. |
| 4. ANACSRC | Source program of analysis of covariance subroutines in Modify Source Input Form. |
| 5. RA1 | Sample directory |
| 6. RA2 | Urine sample file |
| 7. RA3 | Blood sample file |
| 8. RA4 | Daily parameters |
| 9. FMAN1 | Auxiliary file - Man 1, Skylab 3. |
| 10. FMAN2 | Auxiliary file - Man 2, Skylab 3. |
| 11. FMAN3 | Auxiliary file - Man 3, Skylab 3. |

## 4.0 REFERENCES


1. Giese, R. P., A Data Storage and Retrieval System for Endocrine Research, Contract NAS 9 - 13042, Department of Biomathematics, M. D. Anderson Hospital and Tumor Institute, 6723 Bertner, Houston, Texas, December, 1973.

2. Newton, L. and Johnston, D. A., A Data Storage, Retrieval, and Analysis System for Endocrine Research, Contract NAS 9 - 13042, Department of Biomathematics, M. D. Anderson Hospital and Tumor Institute, 6723 Bertner, Houston, Texas, November, 1974.

3. Johnston, D. A., Statistical Analysis of Skylab III, Contract NAS 9 - 13042, Department of Biomathematics, M. D. Anderson Hospital and Tumor Institute, 6723 Bertner, Houston, Texas, November, 1974.